



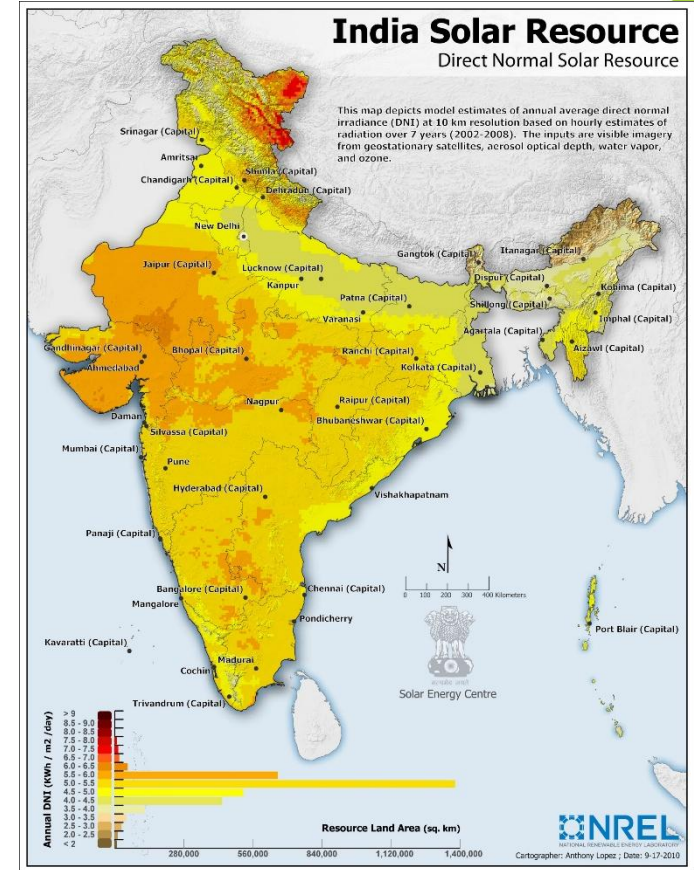
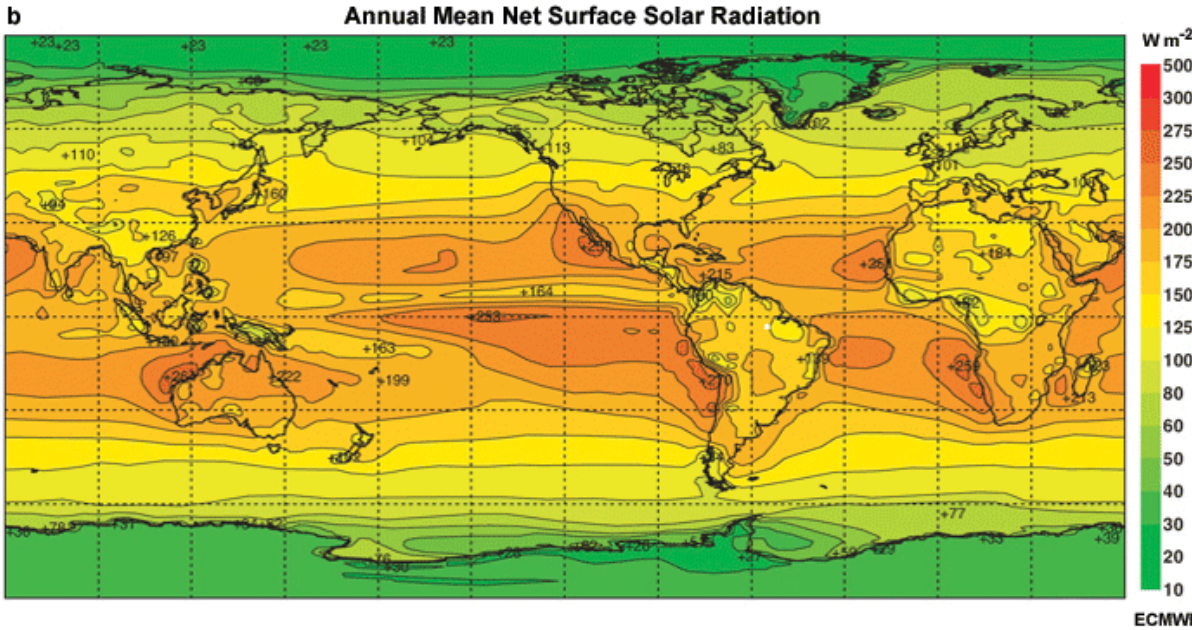
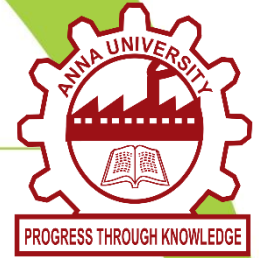
# Solar Air conditioning Systems

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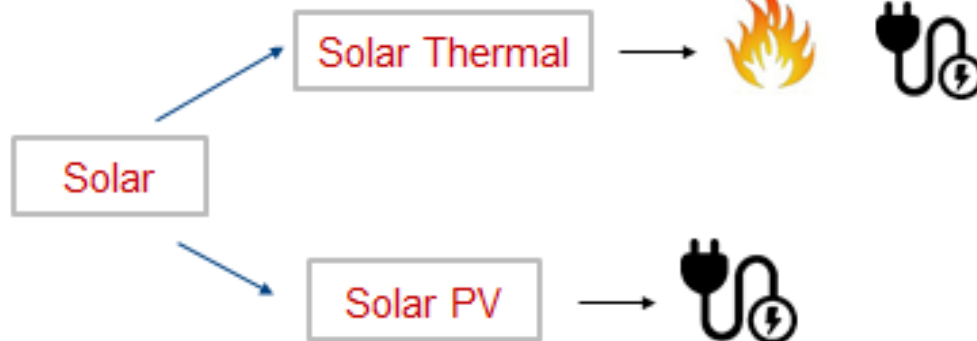
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&

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# Solar Energy

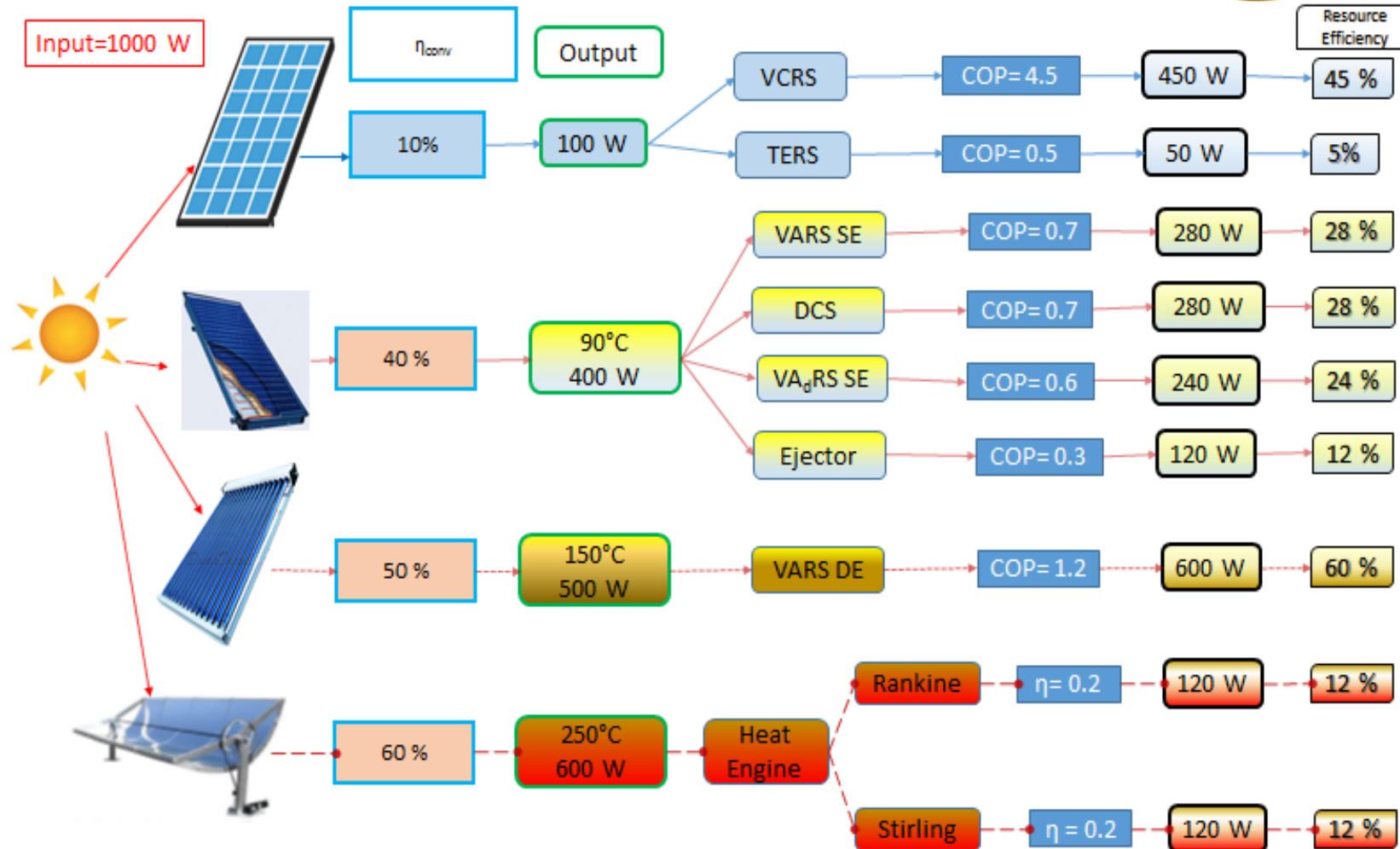


80% of the daily incident solar energy is heat. Solar Thermal focuses on the collection and use of heat generated by the Sun.



20% of the daily incident solar energy is light. Solar PV focuses on the production of electricity using the Sun's incident light energy.

# Solar Cooling Technologies



# PV vs Thermal for ACS



- **For the PV operated VCRS,**
  - Daily solar radiation on the collector : 7.5 kWh /m<sup>2</sup>/day
  - Efficiency @ 10 %
  - Daily Electrical energy production : 0.75 kWh /m<sup>2</sup>/day
  - Cooling Production : 0.75 x 4.5 (COP) WC : 3.37 kWh/m<sup>2</sup>/d  
: 0.75 x 3 (COP) AC : 2.25 kWh/m<sup>2</sup>/d
- **For Solar Thermal VAM with ETC @ 50 %**
  - Cooling Production : 3.75 x 0.7 (COP SEVAM): 2.62 kWh/m<sup>2</sup>/d  
: 3.75 x 1.2 (COP DEVAM): 4.50 kWh/m<sup>2</sup>/d

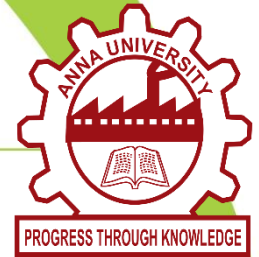
**BEST Solar Thermal System : 0.22 – 0.38 m<sup>2</sup> / kWh /day**  
**BEST Solar PV system : 0.29 – 0.44 m<sup>2</sup> / kWh /day**

# Economic Analysis



- Depends upon location, operation and maintenance of the plant.
- Chiller cost for PV is system 1/3 of Thermal Systems
- Solar Cost depends upon the size for both the systems
- Both PV and ETC cost is coming down over the years

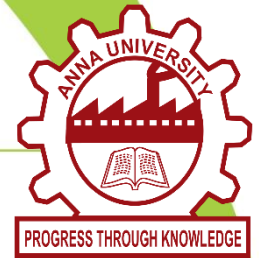
# Estimation-TEWI Calculations



Parameters	VCRS – R134a WC	Solar DEVAM
Capacity	100 TR	100 TR
Years of operation	25 Yrs	25 Yrs
Operating h / year	3500	3500
Power consumption	0.85 kW/TR (COP : 4.2)	5 kW
Refrigerant charge kg	100 kg	1000 kg
Leakage rate	0.5 %	-
Recycling factor	75 %	-
CO <sub>2</sub> emission	1.1 kg of CO <sub>2</sub> /kWh	1.1 kg of CO <sub>2</sub> /kWh
GWP <sub>100</sub>	1430	-
Direct Emission	53,625 kg of CO <sub>2</sub>	-
In Direct Emission	81,81,250 kg of CO <sub>2</sub>	4, 81,250 kg of CO <sub>2</sub>
<b>TEWI</b>	<b>82, 34, 875 kg of CO<sub>2</sub></b>	<b>4, 81, 250 kg of CO<sub>2</sub></b>

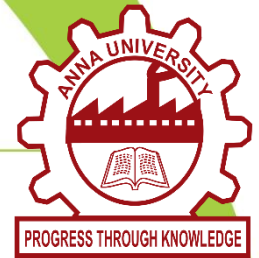
**The CO<sub>2</sub> emission for solar absorption system is approximately 6 % of Conventional vapor compression system**

# Concluding remarks



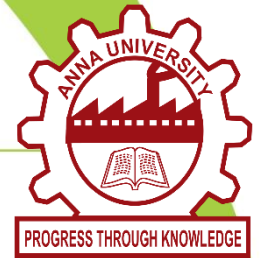
- Solar Air conditioning Systems
- Industrial and commercial sector – Larger central systems in place already
- Often coincide of loads and solar gains
- Residential sector – great future challenge
- Lacking affordable, small scale technologies
- Highest load in non-sunshine hours
- Non coincide of supply and demand, challenge of storage

# Concluding remarks



- Solar thermal system is better than PV system for cooling applications from area requirements and resource efficiency consideration
- Investment cost for Solar thermal systems are costlier than PV system at present due to reduction in PV cell cost and also increase in cell efficiency
- Vapour compression chillers of higher COP at 6 is looked upon closer to solar based DEVAM
- For both the systems Energy Storage is the KEY factor for the successful implementation





Thank you very much